

**CALFED Bay-Delta Program  
Ecosystem Restoration Program**

---

**Prototypes:  
Vision for the Sacramento River Ecological Zone,  
Vision for Chinook Salmon  
and  
Draft Examples of  
Ecosystem Restoration Program Plan  
Stepdown Objectives Technical Appendix**

---

**DRAFT REVIEW AND DISCUSSION MATERIALS**

**December 12, 1996**

**CALFED Bay-Delta Program  
Ecosystem Restoration Program**

---

**Prototypes:  
Vision for the Sacramento River Ecological Zone,  
Vision for Chinook Salmon  
and  
Draft Examples of  
Ecosystem Restoration Program Plan  
Stepdown Objectives Technical Appendix**

---

**DRAFT REVIEW AND DISCUSSION MATERIALS**

**Prepared under the direction of**

**Dick Daniel  
CALFED Bay-Delta Program**

**by:**

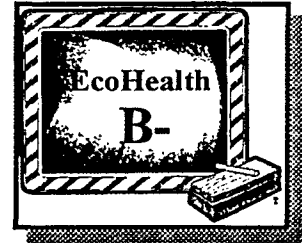
**Terry J. Mills  
and  
Frank Wernette  
California Department of Fish and Game**

**Steve Chainey,  
Tom Cannon,  
and  
Pete Rawlings  
Jones and Stokes, Associates**

**December 12, 1996**

## Vision for the Sacramento River Ecological Zone

The CALFED vision for the Sacramento River Ecological Zone includes restoration of its important plant, wildlife and fishery communities to a condition of health. Health will be attained when the status of these resources is no longer considered of concern or a problem in the Sacramento-San Joaquin Delta. In attaining this vision, CALFED will seek to restore or reactivate to the level necessary important ecological processes and functions which create and maintain habitats for the plant, wildlife and fishery communities along and in the Sacramento River. CALFED's vision strongly focuses on restoration of the Sacramento River winter-run chinook salmon, protecting juveniles of the other chinook salmon stocks and steelhead as they rear and migrate downstream. CALFED's vision in protecting and increasing the survival of juvenile salmonids will emphasize the maintenance and restoration of a healthy riparian zone between Keswick Dam and Verona. This includes ample shaded riverine aquatic habitats, woody debris and biologically productive gravel beds for spawning and invertebrate production. It also includes the creation of complex aquatic habitats in the Sacramento River below Verona which will provide escape cover. The vision also anticipates reducing the input of heavy metals and other contaminants and the installation of positive barrier fish screens on water diversions.



CALFED envisions that municipal, agricultural, wildlife, fisheries, and riparian needs of the Sacramento River Ecological Zone will be reached and ecosystem health of the Sacramento River will be achieved when the following targets have been satisfactorily attained.

- Improved or unobstructed upstream and downstream passage at major water diversion structures near Redding and Red Bluff,
- Most of the water is diverted from the river (by volume) through positive barrier fish screens and irrigators screen all the largest diversions,
- Flows are provided to restore ecological processes and functions which maintain habitats important to plant, fish and wildlife species,
- A plan is developed and carried out to manage and restore scrub, woodland, and forests along the Sacramento River,
- Natural sources of instream and off-stream gravel recruitment are protected and restored,
- Water temperature control in the Keswick Dam to Red Bluff Diversion Dam reach is improved,
- The discharge of heavy metals and other organic and inorganic toxics into the Sacramento River is reduced to acceptable levels,
- Flow fluctuations below Keswick Dam to adjust the flashboards at the Anderson-Cottonwood Irrigation District's diversion dam on the main stem Sacramento River are reduced or eliminated,
- Sacramento River winter-run chinook salmon maintain a cohort replacement rate  $> 1.0$  until the spawning population attains a level of 10,000 females per year and then maintain a replacement rate of  $\geq 1.0$ , as recommended by the Sacramento River Winter-run Chinook Salmon Recovery Team,

• All you can as quick as you can?  
Do some monitor Do some  
Demo/Proto

## Vision for the Sacramento River Ecological Zone

---

- Fall-run, and late-fall-run chinook salmon populations maintain a cohort replacement rates  $>1.0$  during stock rebuilding and then maintain a replacement rate of  $\geq 1.0$ ,
- Steelhead populations maintain a cohort replacement rate of  $>1.0$  during stock rebuilding and then maintain a replacement rate of  $\geq 1.0$ , and
- Other native fish communities and populations maintain population growth rates of 1.0 or greater.

### Background

The Sacramento River, more than 300 miles long from below Lake Shasta to Collinsville in the Delta where it joins the San Joaquin River, is a major western river and the largest and most important riverine ecosystem in the state of California. This stately river provides most of the water, nutrients, sediment, and anadromous fish entering the Bay-Delta ecosystem. The river corridor encompasses more than 250,000 acres of natural, agricultural, and urban lands upstream of Sacramento.

The Sacramento River Ecological Zone includes 242 miles of the main stem Sacramento River from Keswick Dam near Redding to the American River at Sacramento. (The remaining 60 miles of the lower river downstream of Sacramento is included in the North Delta Ecological Zone). The mainstem river planning area includes the river channel, gravel bars and vegetated terraces, the 100-year river floodplain, and the geologic-defined band of historic and potential river migration (i.e., the "meander belt"). In the artificially narrow leveed reach downstream of Colusa to Sacramento, an approximately one mile wide band of river alluvium and historic and potential forest land that borders the levees is also included in this ecological zone. The entire ecological zone is depicted in Figure x-x.

Historically the riparian forest corridor along the river averaged 4-5 miles wide and encompassed a significantly large area, whereas today only 5 percent of the forests remains. Only one third of the river length has natural banks and floodplain terraces, the other two thirds have been modified and confined by levees, riprap, and flood control projects. These structures limit the dynamic forces that promote natural habitat succession and regeneration along the river. Channelization and bank protection between Chico Landing and the Delta eliminates and degrades many habitats by increasing the depth and velocity of flow and by reducing the hydraulic and substrate diversity associated with more natural or undeveloped river systems. Bank protection also reduces the amount of fresh gravel and shaded riverine aquatic habitat available to the river through bank erosion.

Over 100 miles of the Sacramento River between Red Bluff and Colusa are wholly or partially intact as a dynamic alluvial river meander belt. Although about 20 percent of its banks are contained by riprap protecting levees and orchards, the river continues to erode its banks naturally and form new banks from gravel and sediment deposits on point bars and terraces. These fluvial geomorphic features support a time-dependent succession of young and old growth forest and wildlife habitat that requires 65-100 years to reach full maturity (climax succession to valley oak woodland). New sediment and gravel that sustains this process is supplied by a

## **Vision for the Sacramento River Ecological Zone**

---

combination of eroding banks along the mainstem river and input from unregulated upstream tributaries. New fish habitat is created by the migrating gravel riffles and deeper pools formed at bendways, and by mature trees and roots that overhang or topple into the channel as the river naturally erodes through older alluvial deposits supporting climax vegetation.

The Sacramento River Ecological Zone is dependent on virtually all its adjacent Ecological Zones which cumulative contribute to the maintenance of important ecological processes and functions, particularly water, sediments, and nutrients. For the most part, the metamorphic rocks of the Klamath Mountains are resistant to erosion and do not produce much gravel. The Coast Ranges are also metamorphic rocks, but in contrast, produce large amounts of both suspended sediment and gravel. More recent sedimentary rocks of clay, silt, sand, and gravel (semi-consolidated deposits) are highly erodible and provide large quantities of sediments and gravel to the westside streams, and therefore, the Sacramento River. However, many large westside streams no longer provide significant sediment and gravel to the mainstem river because of the placement of large reservoirs or sediment control basins, and the effects of instream gravel mining.

Shasta Dam and diversion from the Trinity River control Sacramento River flow in the upper end through flow releases at Whiskeytown Lake, Spring Creek and Shasta Dam. Tributaries provide a significant quantity of flow accretion, particularly through the winter and spring months. The Sutter and Yolo bypasses redirect vast quantity of flow from the mainstem river during high flow periods and are integral components of the Sacramento River flood control project.

Various cropland habitats occur on flat and gently rolling terrain adjacent to most of this zone and may not correspond to regional natural habitat stages. Irrigated crops grown are mostly orchards, rice, grains, and alfalfa. Most of this cropland is irrigated from water diverted from the Sacramento River or its tributaries. Croplands can provide numerous benefits to this zone with minimal changes to irrigation diversions identified in the targets below.

Cottonwood Creek is the most important watershed component in the upper river downstream of Shasta Reservoir and controls and supports the maintenance of ecological processes and functions in the upper Sacramento River. The Cottonwood Creek Ecological Zone is discussed separately, but its importance to the ecological health of the upper Sacramento River is emphasized here because it is the largest remaining undamed tributary with natural hydrology and sediment characteristics. In the winter flood of 1986, over half the flow (and presumably gravel and sediment) in the Sacramento River originated in Cottonwood Creek, double the volume represented by all other north valley streams combined.

Other key components in the Sacramento River Ecological Zone include the many permanent and seasonal tributary stream mouths and oxbow lakes along the mainstem which are important backwater rearing areas for juvenile fish and provide major sources of nutrients, instream woody material, sediment, and gravel.

## **Vision for the Sacramento River Ecological Zone**

---

**Reach 1** - The Keswick Dam to Red Bluff Diversion Dam Reach (59 miles from RM 302 to RM 243) includes the mouths of Ash, Bear, Cow, Inks, Battle, Paynes, and Antelope creeks draining Mount Lassen, and Spring, Clear, and Cottonwood creeks drain the Coast Range and Klamath Mountains. About four miles below Keswick Dam, the river widens to about 500 feet before entering the alluvial plains of the Sacramento Valley near Red Bluff. South of Red Bluff, it is a broad alluvial river system controlled by its own water discharge and sediment deposits.

**Reach 2** - The Red Bluff Diversion Dam to Chico Landing Reach (49 miles from RM 243 to RM 194) includes the mouths of eastside tributaries of the Sacramento River that drain Mount Lassen and the northern Sierra Nevada, including Mill, Deer, Pine, Rock, and Big Chico creeks. Westside streams that drain the upper valley and parts of the Coast Range include Red Bank, Elder, and Thomes creeks. The extent of river floodplain and active channel meander belt from Red Bluff to Chico Landing is relatively unchanged in nature. With restoration it can continue to provide for the maintenance of important ecological processes and functions such as hydrologic regimes, stream channel meander, gravel recruitment, and gravel cleansing.

**Reach 3** - The Chico Landing to Colusa Reach (51 miles from RM 194 to RM 143) includes the mouth of Stony Creek and no other major tributaries. In this reach, most of the high flow during storm runoff events leaves the river along the east bank and enters the expansive floodplain of Butte Basin via three major flood relief outfalls at M&T Ranch, 3B's, and Parrot Ranch, and farther downstream via the Moulton and Colusa Weirs near Colusa. Much of the river downstream of Chico Landing has been subject to flood control with an extensive system of levees, basin and bypass outflows, and streambank protective measures such as riprap that attempt to halt natural channel migration by fixing the river in a static position.

**Reach 4** - The Colusa to Verona Reach (63 miles from RM 143 to RM 80) includes the mouth of the Butte Slough outfall gate, but no important tributary inflow until the Colusa Basin Drain enters the river near Knights Landing at RM 90. High flows leave the river via the Colusa and Tisdale Weirs, and farther downstream most flow from the Sutter Bypass/Butte Slough and Sacramento River leaves the river again at the Fremont Weir and flows in the Yolo Bypass to the Delta at Rio Vista.

**Reach 5** - The Verona to Sacramento Ecological Unit (20 miles from RM 80 to RM 60) includes important tributary inflow from the Feather River at RM 80 and the American River at RM 60, and high flow outfall to the Yolo Bypass via the Sacramento Weir.

### **Identification, Status and Restoration Needs of Ecologically Important Processes, Resources, Habitats, and Stressors**

The most important physical processes and ecological structures within the Sacramento River Ecological Zone are summarized below. The vision for this river zone is to maintain, reestablish, or augment these processes and structures wherever possible:

## Vision for the Sacramento River Ecological Zone

---

- frequent winter and spring storm flow peaks that inundate the vegetated river floodplain, transport and redeposit gravel and sediment, erode natural banks, and create new substrate for riparian forest to reseed and germinate in the spring,
- a one to five mile wide meander belt and riparian corridor where the river is allowed to migrate within defined limits, and support a diverse age class structure of successional vegetation, clean gravel bars, and form backwater oxbow channels connected to the main river at low flow,
- an annual hydrograph that mimics pre-Shasta patterns, including adequate low water temperatures to support spawning, incubation, and juvenile rearing success between Keswick and Chico Landing, and naturally lower flows during the growing season to prevent premature inundation and mortality of riparian seedlings,
- hydrologic and physical connectedness with major east and west side tributaries that supply unregulated peak flows, new gravel, organic matter, and sediment, and major rearing habitat and migration corridors to other watersheds, and
- in general, a reliance on integration of natural physical processes that create and sustain continuous habitats along the mainstem river with a minimum of artificial means needed to restore any one habitat type. This vision approach is most applicable from Keswick to Colusa, but new and enlarged nodes or stringers of riparian forest and shaded riverine aquatic habitats can be created by tapping and unleashing physical processes downstream of Colusa as well.

Significant stressors of ecological functions, habitats, and species on the Sacramento River include bank protection (i.e., new riprap) and the artificial confinement of the river channel by the infrastructure of the Sacramento River Flood Control Project, adjacent land use (e.g., expansion of roads, subdivisions, orchards, and crops on flood terraces within the meander belt), reservoir management that reduces the magnitude, frequency, and duration of natural peak storm flows, absence of gravel and sediment supply downstream of the extensive system of flood control and water storage reservoirs, instream gravel mining that exceeds annual sustainable yield on tributaries, inflow of water contaminants (especially Iron Mountain Mine and the Colusa Basin Drain), invasive riparian exotic shrubs (giant reed and tamarisk) competing for space with new riparian stands, overharvest of fish and wildlife, and predation and competition with anadromous species from introduced and hatchery fish.

Important habitats provided by the Sacramento River and its ecological processes and functions include eroding banks, shaded riverine and near-shore aquatic habitat, riparian forest succession, valley oak woodland, various cropland habitats including agricultural wetlands and uplands, and migration, holding, spawning, nursery, and emigration habitats for anadromous and resident fish populations. Important resident and anadromous rearing habitats include oxbow lakes, backwater channels, tributary mouths, and permanent marsh or lake habitat associated with active floodplain basins along the river.

## Vision for the Sacramento River Ecological Zone

---

Important fish, wildlife, and plant species occupying the Sacramento River Ecological Zone and its habitats include winter-run chinook salmon, fall-run chinook salmon, late-fall-run chinook salmon, spring-run chinook salmon, steelhead, green sturgeon, white sturgeon, American shad, striped bass, waterfowl, neotropical migrant bird species dependent on high quality riparian habitats, valley oak woodland, and native riparian forest species.

### Vision for Ecological Units

**Keswick Dam to Red Bluff Diversion Dam Vision (Reach 1):** The CALFED vision for the Keswick Dam to Red Bluff Diversion Dam Ecological Unit highlights the restoration of ecological processes that naturally create and sustain habitats needed to support and restore the endangered Sacramento winter-run chinook salmon and species of special concern such as steelhead, spring-run chinook, fall-run chinook, and late-fall-run chinook. The vision includes maintaining a flow pattern that emulates the natural hydrologic regime to the extent possible given the high level of development of water and flood storage in the upper section. Important ecological functions of flow include maintaining the natural stream meander and gravel recruitment processes; sediment transportation and deposition; protecting the limited riparian corridor in this section; and preventing potential catastrophic fish losses due to an uncontrolled spill of toxic materials from Iron Mountain Mine and Spring Creek Debris Dam overflow.

This ecological unit encompasses a significant portion of critical nursery area required by the endangered winter-run chinook salmon, and CALFED envisions that most of the water diversions in this reach will have positive barrier fish screens installed to protect all juvenile salmon and steelhead.

CALFED also envision that nursery areas for juvenile salmon would be improved through the restoration of waterside emergent and riparian vegetation throughout this unit and particularly in areas immediately downstream of the mouths of some of the tributaries described above.

**Red Bluff Diversion Dam to Chico Landing Vision (Reach 2):** The CALFED vision for the Red Bluff Diversion Dam to Chico Landing Ecological Unit emphasizes the quantity and quality of the riparian corridor and its associated riparian forest. The ecological processes needed to restore the riparian component are also extremely important for maintaining many important fish and wildlife resources that depend on habitats within the unit. Important elements needed to attain the CALFED vision for this unit include specific provisions for processes that maintain high quality habitat for winter-run chinook salmon and steelhead and other anadromous fish species.

Restoration of endangered species and species of special concern requires that water management activities be consistent with maintaining ecological processes. These include flows that emulate the natural hydrologic regime to the extent possible and are compatible with the high level of development of water in the upper section. Important considerations include flows needed to maintain natural stream meander processes and gravel recruitment, transport and deposition.



## Vision for the Sacramento River Ecological Zone

This ecological unit encompasses an important portion of critical nursery and emigration area required by the endangered winter-run chinook salmon, and CALFED envisions that most of the water diverted in the section will use positive barrier fish screens to protect juvenile fish.

In this unit CALFED envisions the restoration of broad riparian corridors that are connected and not subject to fragmentation. These corridors would connect larger blocks of riparian typically greater than 50 acres. These blocks would be large enough to support the natural convection currents of air flowing from the forests across the river causing evaporative cooling of the river. The riparian corridors would generally be greater than 100 meters wide and would support increased populations of neotropical migrants such as the yellow-billed cuckoo and unique furbearers such as the ring-tailed cat. Species such as the bank swallow will benefit from the restoration of the processes that create and maintain habitat within this unit.

CALFED also envisions that nursery areas for juvenile salmon would be improved through the restoration of waterside emergent and riparian vegetation throughout the unit and particularly downstream of the mouths of some of the tributaries described above.

**Chico Landing to Colusa Vision (Reach 3):** The CALFED vision for the Chico Landing to Verona Ecological Unit provides improved habitat and increased survival of many important fish and wildlife resources. Important elements needed to attain the CALFED vision for this unit include specific processes that maintain high quality habitat for chinook salmon and steelhead, besides the other anadromous fish species.

Restoration of endangered species and species of special concern requires that water management activities be consistent with maintaining ecological processes. These include flows that emulate the natural hydrologic regime consistent with the high level of development of water in the upper section. Important considerations include flows needed to maintain natural stream meander processes and gravel recruitment, transport and deposition, maintenance of the limited riparian corridor in this section.

Closure of gaps in the shoreline riparian vegetation and near shore aquatic habitat will be accomplished through a reduction of vegetation management by local reclamation districts, and enhancement of channel banks through the modification of levees and berms that incorporate habitat structures such as "fish groins" and low waterside berms supporting natural growth and woody debris.

This ecological unit encompasses a significant portion of the critical migration habitat required by the endangered winter-run chinook salmon, and CALFED envisions that most of the water diverted in the section will use positive barrier fish screens to protect juvenile fish.

In this unit, CALFED envisions the restoration of broad riparian corridors interconnected with narrower corridors that are not subject to fragmentation. These corridors would connect larger blocks of riparian typically greater than 50 acres. These blocks would be large enough to support the natural convection currents of air flowing from the forests across the river causing

## Vision for the Sacramento River Ecological Zone

---

evaporative cooling of the river. The wider riparian corridors would generally be greater than 100 meters wide and would support increased populations of neotropical migrants such as the yellow-billed cuckoo. Cavity nesting species such as the wood duck and special status species such as the bank swallow will benefit from the restoration of the processes that create and maintain habitat within this unit. The narrower corridors would range between 10 and 25 meters wide.

CALFED also envisions that nursery areas for juvenile salmon would be improved through the restoration of waterside emergent and riparian vegetation throughout this unit and particularly in areas immediately downstream of the mouth of the Feather River.

**Colusa to Verona Vision (Reach 4):** The CALFED vision for the Colusa to Verona Ecological Unit provides improved habitat and increased survival of many important fish and wildlife resources. Important elements needed to attain the CALFED vision for this unit include specific processes that maintain high quality habitat for chinook salmon and steelhead, besides the other anadromous fish species. This reach is an important seasonal component of the critical migration habitat required by the endangered winter-run chinook salmon, and CALFED envisions that much of the water diverted in the section will use positive barrier fish screens to protect juvenile fish.

**Verona to Sacramento Vision (Reach 5):** The CALFED vision for the Verona to Sacramento Ecological Unit provides for many important fish and wildlife resources that depend on partially operational ecological processes and functions. Important elements needed to attain the CALFED vision for this unit include specific processes that maintain high quality nursery and migration habitat for adult and juvenile winter-run chinook salmon and steelhead, and other anadromous fish species.

Restoration of endangered species and species of special concern requires that water management activities be consistent with maintaining ecological processes. These include flows that emulate the natural hydrologic regime to the extent possible. Important considerations include flows to maintain natural stream meander processes and gravel recruitment, transport and deposition, maintaining a limited but continuous riparian corridor, and reducing potential fish losses due to toxic residues from agricultural tailwater.

Closure of gaps in the shoreline riparian vegetation and near shore aquatic habitat will be accomplished through a reduction of vegetation management by local reclamation districts, and enhancement of channel banks through the modification of levees and berms that incorporate habitat structures such as "fish groins" and low waterside berms supporting natural growth and woody debris.

This ecological unit encompasses a significant portion of critical nursery area required by the endangered winter-run chinook salmon, and CALFED envisions that most of the water diverted in the section will use positive barrier fish screens to protect juvenile fish.

## **Vision for the Sacramento River Ecological Zone**

---

In this unit, CALFED envisions the restoration of narrower riparian corridors that are connected and not subject to fragmentation. These corridors would connect larger blocks of riparian typically greater than 50 acres. These blocks would be large enough to support the natural convection currents of air flowing from the forests across the river causing evaporative cooling of the river. The riparian corridors would generally be 10 to 25 meters wide and would support cavity nesting species such as the wood duck and would provide perch and nest sites for raptors such as the Swainson's hawk.

CALFED also envision that nursery areas for juvenile salmon would be improved through the restoration of waterside emergent and riparian vegetation throughout this unit and particularly in areas immediately downstream of the mouth of the American River.

### **Pathways to Vision**

Overall, CALFED anticipates that its vision for the Sacramento River Ecological Zone will nurture and augment other important ongoing and future restoration efforts for the zone. In particular, the CALFED vision will greatly supplement the National Marine Fisheries Service's needs for restoration of the endangered winter-run chinook salmon and other potential salmon and steelhead stocks presently under status review for inclusion in the list of endangered species. CALFED's vision for the Sacramento River Ecological Zone will also improve the benefits from the U.S. Fish and Wildlife Service's Anadromous Fish Restoration Plan which strives to double the natural production of anadromous fish in the system over the average production during 1967-1991. Likewise, the CALFED vision will help the Department of Fish and Game as it progresses toward doubling the number of anadromous fish over the number present in 1988. Finally, the CALFED vision for this important ecological zone will help the Upper Sacramento River Advisory Council's Riparian Habitat Committee (a.k.a. SB1086 committee) as it progresses with its plan to restore a naturally-sustained riparian corridor, including a designated meander belt and extensive forests, between Keswick Dam and Verona.

### **Linkage to Other Ecological Zones**

Restoration and maintenance of ecological processes and functions in the Sacramento River Ecological Zone are highly dependent on actions and conditions in adjacent zones. For example, the maintenance of the riparian forests and stream meander quality of the Sacramento River above Chico Landing is highly dependent on input of flow and sediments from Cottonwood Creek and undamed tributaries draining Mount Shasta and the northern Sierra Nevada. Therefore, maintaining and restoring important ecological processes in Cottonwood Creek and other unregulated tributaries is essential to maintain the ecosystem health of the Sacramento River.

Likewise, some fish species depend exclusively on the Sacramento River for migration, spawning, and nursery habitat, while some species that use other ecological zones for spawning use the Sacramento River as primary migration, nursery and emigration habitat. Other important ecological zones dependent on the resources of the Sacramento River include the Sacramento-

## Vision for the Sacramento River Ecological Zone

---

San Joaquin Delta Ecological Zone and the Suisun Marsh/San Francisco Bay Ecological Zone. These zones in turn provide essential food web prey species and critical rearing habitat for outmigrating anadromous fish that spawn in the Sacramento River and its major tributaries.

Additionally, stressors important to fish and wildlife species using the Sacramento River during at least part of their life cycle occur outside the identified ecological zones. For example, ocean recreational and commercial salmon fisheries remove a large portion of the potential adult spawners from the population each year. New harvest management strategies for the ocean fisheries will be needed to augment improvement to inland ecological processes and functions that maintain key habitats for salmon. Water quality of agricultural tailwater throughout the Colusa Basin that reenters the Sacramento River at Knights Landing or Prospect Slough (Yolo Bypass) affects the health and survival of juvenile fish and prey species in the river, depending on the temperature, toxicity level, and dilution ratios present.